Final Report

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Cost-effective methods for evaluation of Neighbourhood Renewal programs

authored by

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ACRONYMS

AHURI	Australian Housing and Urban Research Institute Limited
CBD	Central Business District
DHS	Department of Human Services
GIS	Geographic Information Systems
HUD	Department of Housing and Urban Development
ICSEA	Index of Community Socio-Educational Advantage
ISR	Institute for Social Research
MTO	Moving to Opportunities
NR	Neighbourhood Renewal
SEIFA	Socio-Economic Indexes for Areas
SLA	Statistical Local Area
VG	Victorian Valuer-General

1 INTRODUCTION

1.1 Overview

An important goal of the National Housing Reform Agenda is to 'reduce concentrations of disadvantage that exist in some social housing estates' (AHURI 2011, p.3). There is a growing body of Australian evidence indicating that the stigmatisation of housing in poorer neighbourhoods is associated with inferior access to health and education services and relatively low levels of wellbeing (Bridge et al. 2003; Stone & Hulse 2007; Hulse & Saugeres 2008). This has motivated Australian State Housing Authorities to introduce Neighbourhood Renewal programs to improve housing quality and strengthen service delivery within disadvantaged communities that have concentrations of social housing. These programs aim to generate positive non-shelter outcomes and strengthen social cohesion within targeted communities.

This project aims to design and implement a robust quasi-experimental methodology for the evaluation of urban renewal programs. This is not the first Australian attempt at such an evaluation; but this proposal departs from previous survey based studies (Wood 2002; Randolph et al. 2004; Walker et al. 2007), by using quantitative techniques to arrive at financial measures of the non-shelter benefits generated by renewal programs. It is not put forward as an alternative to existing approaches to the evaluation of Australian neighbourhood renewal programs. We suggest these quasi-experimental methods be viewed as a complement to evaluations using community surveys and administrative data.

The approach has a sound conceptual basis grounded in economic analyses of housing markets showing that, if renewal programs yield benefits such as improved physical appearance, reductions in crime, vandalism and so on, the demand for private housing in and around the targeted areas will increase. The favourable shift in demand will increase house prices struck on transactions in post-Neighbourhood Renewal periods (Zielenbach, Voith & Mariano 2010; Rossi-Hansberg, Sarte & Owens 2010). In short, if there are benefits they will generate house price premiums.

We have accessed the Victorian Valuer General's database of transactions to construct house price profiles before and after the introduction of neighbourhood renewal programs in Melbourne. These profiles are compared with those from a control group of neighbourhoods and properties that have been selected using criteria that ensure they are comparable to those in the vicinity of targeted (treatment) areas. In other words the control sample acts as a counterfactual portrait of house prices in targeted areas if they had not been exposed to neighbourhood renewal. The difference in price trends in private housing transactions in the 'treatment areas' and those in the 'control areas' is the basis for price premium estimates that are then used to generate financial estimates of benefits.

The research has a number of novel and attractive attributes:

- The quantitative analysis is based on secondary data sets with proven uses in policy analysis (Goodman et al. 2010).
- It is much less costly to implement than survey-based evaluations.
- While the US Department of Housing and Urban Development (HUD) has made extensive use of this quasi-experimental approach in evaluations of housing programs, including urban renewal (Santiago et al. 2001; Galster et al. 2004; Castells 2010), this proposal would be one of the first Australian applications.

1.2 Significance of the Research

The approach relates a financial measure of Neighbourhood Renewal benefits to total state government capital, grant and administration outlays. There are at least two outputs; one is a benefit to cost ratio for each neighbourhood renewal area and therefore a measure of whether returns to government investment are small or large, and whether they have varied across the Neighbourhood Renewal areas. The other is a systematic analysis of how differences in the emphasis of each project, say between capital and other outlays, may shape the success or otherwise of Neighbourhood Renewal.

There is a second potentially important contribution. Economic theory predicts that if neighbourhood renewal has incidental benefits then property prices will increase in areas exposed to the program. State governments add stamp duty to the prices paid by home buyers and investors, and levy land taxes on the land occupied by rental dwellings, while local governments raise property taxes on the unimproved capital values of all land plots. The revenues generated by these three taxes will increase in the areas impacted by neighbourhood renewal. The data bases we have assembled allow an estimate of the additional stamp duty revenues generated in our selection of neighbourhood renewal areas. We believe this is the first Australian study to quantify the possible returns to state governments on the revenue side of their budgets.

Finally this project is, as far as we are aware, the first to apply these kinds of quasi-experimental techniques in Australian housing and urban studies. In principle these techniques can be used to estimate the incidental benefits or costs of numerous government interventions in urban systems. Where there is geographical variation in the application of regulations, urban infrastructure investments or the provisions defining taxes and charges, property transaction data bases such as those used in this study can be invoked to measure benefits and costs.

In Chapter 2 we outline both the equity and efficiency rationale for neighbourhood renewal, and describe the Victorian program since its inception in 2001. We also take a brief look at neighbourhood renewal in North America and Western Europe. Chapter 3 concentrates on method; it focuses on the most important part of our approach—the matching of a control sample of properties with those exposed to neighbourhood renewal. It is this propensity score matching technique that distinguishes our study from its predecessors. In addition, variable measures are defined and descriptive statistics presented. The rest of the report presents results and discusses their meaning. Chapter 4 presents key findings and their implications. A concluding chapter sums up, and offers some suggestions for future research directions.

2 NEIGHBOURHOOD RENEWAL: RATIONALE, APPROACH AND EVALUATION

2.1 Rationale

Wide disparities in community incomes, employment and housing standards offer an equity rationale for government intervention in the form of place based program. It is then common for the goals of neighbourhood renewal to include closing the gap between targeted disadvantaged communities and the rest of the city/state or country. Community mix has also motivated neighbourhood renewal programs that seek to attract middle-income, economically-active households to renewal areas and thereby break up concentrations of poverty (Meen 2012, forthcoming).

But there is a second efficiency rationale motivating neighbourhood renewal interventions and it is based on the concept of externalities (Rossi-Hansberg, Sarte & Owens 2010). Characteristics of a neighbourhood and its properties are both key determinants of house prices; properties and their occupants are potentially important because (in cities and towns where population densities are high) property condition and the behaviour of neighbours will have incidental impacts on those living in the vicinity. The incidental effects (e.g. crime, home renovations and so on) are nonmarket interactions; though they have economic costs and benefits they are not traded in markets. For example, those renovating their properties do not receive compensation from their neighbours in recognition of the positive impact on neighbour property values. Those responsible for vandalism to community facilities (e.g. parks) are not obliged to pay a price that will offset the harm to nearby property values. As these incidental effects are not captured in market transactions there will be an undersupply of those activities responsible for positive incidental impacts, and a corresponding oversupply of those activities responsible for negative incidental impacts. This is an inefficient outcome because of the misallocation of resources that results. In blighted neighbourhoods these incidental effects are typically negative; property values suffer and their owners will in turn under invest, and this will in principle include the owners of business premises and their productivity.

Economists use the term housing externalities to describe these neighbourhood phenomena (see Rossi-Hansberg 2012, forthcoming); their presence implies that private housing (and commercial property) market outcomes will differ from efficient outcomes. This inefficiency offers a potential rationale for government intervention that aims to reverse the cycle of decline that can be triggered when negative externalities take a firm hold on property values in a community. It follows that measurement of the size and significance of renewal program impacts on property values is critical to an understanding of urban policy interventions such as neighbourhood renewal and their impact.

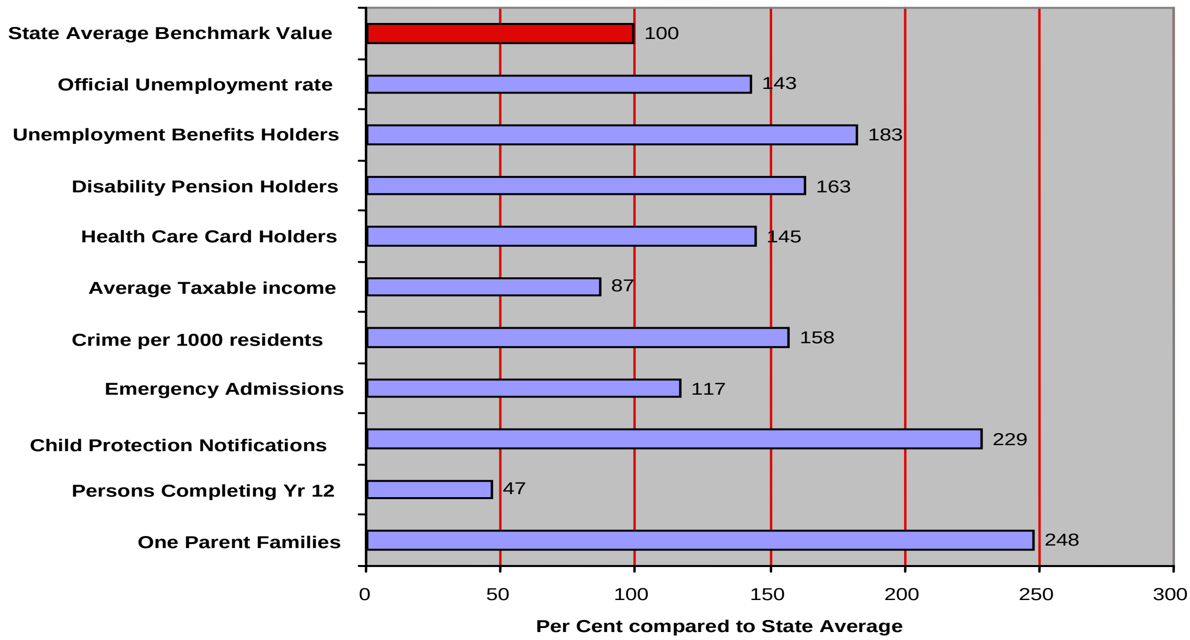
This project aims to make a contribution by estimating the efficiency benefits arising from the positive externalities generated by neighbourhood renewal. The research exercises reported below are thus carried out only for houses not directly the subject of interventions (e.g. external property upgrades, replacement of internal amenities) financed by neighbourhood renewal.

2.2 Approach: Neighbourhood Renewal in Victoria[1]

Neighbourhood Renewal was launched in Victoria in 2002 to narrow the gap between disadvantaged communities, and the rest of the State. In common with HOPE VI in the USA (see Zielenbach, Voith & Mariano 2010), targeted communities have concentrations of public housing. There are nineteen Neighbourhood Renewal project areas spreading across metropolitan and regional Victoria. Each site covers a relatively small clearly defined geographic area, and is selected on the basis of multiple indicators of disadvantage. The population of all but one area ranges from 1000–10 000, the number of housing units from about 300–4000, and the proportion of public housing from 10 per cent to 100 per cent[2] .

Given the use of multiple indicators of disadvantage as selection criteria, areas designated as Neighbourhood Renewal sites are expected to exhibit high concentrations of poverty. This is documented in Figure 1 where the Victorian government's Department of Human Services compares 10 indicators of disadvantage (in 2002) for the postcodes where neighbourhood renewal areas are located, to state-wide benchmarks. A measure exceeding 100 signals an incidence higher than that in the rest of the state. Consider unemployment rates for instance: rates of unemployment turn out to be 43 per cent per cent higher than in the rest of the state. On the other hand, average levels of taxable income in neighbourhood renewal zones are 13 per cent below those achieved in the rest of the state. The overall picture is clearly one of multiple dimensions of disadvantage.

Figure 1: Indicators of disadvantage in Neighbourhood Renewal Areas compared to state averages (by area postcode)



Source: Department of Human Services, June 2009, Neighbourhood Renewal; Creating a Fairer Victoria, Evaluation Framework, State Government of Victoria, p4.

[1] This section draws on Neighbourhood Renewal Unit, Department of Human Services (2008a)

[2] As is explained in more detail in the method section below, those neighbourhood renewal areas containing 100% public housing cannot therefore generate external benefits for private housing within their boundaries.

The 19 Victorian projects are expected to implement a 6-point plan of action to:

- Increase pride and participation.
- Enhance housing and the environment.
- Lift employment, training and education and expand local economies.
- Improve personal safety and reduce crime.
- Promote health and well-being.
- Increase access to services and improve government responsiveness.

(Neighbourhood Renewal Unit, Department of Human Services 2008, p.5)

As is implied by the first of these points of action, the programs eschew a 'top-down' approach to renewal, and instead favour the engagement of communities in decision making. A second feature is the integration of services such as housing, training and crime prevention via so called 'whole of government' coordination groups, that seek to leverage service delivery improvement across the full range of government services.

Expenditure spending by the Victorian State Government on each NR site takes three main forms:

- administration
- grants
- capital.

Administration is outlays incurred on management, implementation and evaluation and encompass items such as the salaries and on costs of place management teams. Grants are a heading under which the department lists budget items for the delivery of specific services such as:

- Employment service initiatives that encourage economic participation by providing opportunities for people to connect with education and employment.
- Community infrastructure projects that improve existing or build new infrastructure to support social and economic participation activities and improve access to services in renewal areas.

Finally capital expenditure includes outlays on construction/redevelopment, upgrades and immediate improvement works (including associated costs e.g. consultancies & feasibility studies).

Comparison with overseas approaches reveals at least two points of difference in emphasis. There is no attempt to use financial inducements to break up spatial concentrations of disadvantage, as in (say) the Moving to Opportunities (MTO) program in the USA (see McClure 2004). In the USA programs such as MTO and HOPEVI aim to move or relocate disadvantaged households from depressed neighbourhoods to areas where job opportunities and services are more abundant. There is also less of an emphasis on improving the social mix in these communities as compared to (say) the UK government's nine Market Renewal Pathfinders in the north of England and the Midlands that were started in 2003 (see Meen 2012, forthcoming).

2.3 Evaluation

The Victorian Government's Department of Human Services has been monitoring the impact of its neighbourhood renewal interventions by conducting regular evaluations. These evaluations use two main sources of data; a community survey repeated every two years and a yearly administrative data collection. The Institute for Social Research

(ISR) at Swinburne University produced the community survey and it has been guided by the Institute's 'Healthy Community' model for measuring progress and wellbeing.

The evaluation is a comprehensive resource intensive exercise with a community survey sample design that includes residents 'exposed' to neighbourhood renewal, as well as a control sample of residents in adjacent areas that are not impacted by the action plans of neighbourhood renewal programs. In neighbourhood renewal areas (treatment groups) the survey is conducted face-to-face with 200–300 local residents aged 18 and over, and uses 91 questions. By including some key questions that are common to the Victorian Population Health Survey and the Local Safety Survey, wider comparisons can be drawn. The survey has been configured to analyse change in resident assessments; thus interviewees are asked about perceptions of current conditions (baseline data) and moreover how things have changed in the previous 12 months (change data).

An abbreviated form of the treatment group survey is administered by telephone to 150 residents selected randomly from ten census collection districts proximate to the Neighbourhood Renewal area (control group). These ten collection districts are ranked in deciles according to their Socio-Economic Indexes for Areas (SEIFA) score, with 15 residents interviewed from each. The use of a control sample strengthens the methodology by offering a counterfactual benchmark with which comparisons can be made.

The survey evidence is complemented by analyses of administrative data extracted from government records such as crime statistics, school attendance and child protection reports. These records have the advantage of being available at a local area scale that facilitates investigation at geographical scales consistent with the boundaries of neighbourhood renewal sites. The regular collection of administrative data also offers advantages over census data which is only available in five-year snapshots.

The 2008 neighbourhood renewal evaluation summary report concludes that the initiative is reducing disadvantage and social exclusion. On numerous indicators the disparity between renewal locations and the rest of the state has contracted. Key outcomes emphasised in the summary report (Neighbourhood Renewal Unit 2008b, p.1) include:

- 4 per cent reduction in unemployment from 17 to 13 per cent, double the rate of reduction in unemployment for Victoria.
- 12 per cent increase in further education qualifications.
- Reduction in average secondary school absenteeism by 3.5 days.
- 4 per cent increase in perceived levels of community participation.
- 12 per cent reduction in overall crime.
- 27 per cent decrease in property crimes.
- 22 per cent increase in acceptance rates for public housing.
- 8 per cent decrease in public housing turnover.
- 6 per cent reduction in substantiated cases of child protection.
- 14 per cent increase in resident perceptions that neighbourhood renewal has improved government performance.
- 33 per cent perceived improvement in housing conditions.
- 23 per cent perceived improvement in the physical environment.

These are impressive findings but are open to the objection that all areas of multiple deprivation in the state have made relative improvements. The period over which neighbourhood renewal programs were implemented and evaluated was pre-GFC and coincided with sustained economic growth and healthy expansion of employment. The advances reported above may then be common to both areas exposed to renewal action plans, as well as those not selected for renewal, but equally disadvantaged.

The evaluation counters this objection by also measuring changes in the disadvantage experienced by people living in Neighbourhood Renewal areas compared with other people of comparative low socio-economic status residing in comparable neighbourhoods. This is a quasi-experimental study design that emulates experimental research methods common in areas such as medical research[3]. It turns out that the more robust quasi-experimental study design also offers strong evidence in support of Neighbourhood Renewal projects. Compared to the control sample drawn from surrounding neighbourhoods, the gap has stopped growing or narrowed on 76 per cent of the indicators used for measurement of disadvantage (Neighbourhood Renewal Unit 2008a, p.4).

Our own study has two main points of departure from the internal evaluations conducted by the Department of Human Services. The reductions in crime and unemployment, improved educational qualifications, improvement in the physical environment and so on that are some of the key findings of the evaluation are positive externalities (non-shelter benefits). It is important to measure the scale and significance of these in resource terms, and the method we propose to use offers a monetary measure of these resource benefits. The approach we invoke for measurement purposes also relies on a quasi-experimental study design. However, the design of control samples employs a more refined methodology that draws on propensity score analysis[4]. These matters of methodology are addressed in the following chapter.

[3] It is common in medical research to randomly assign patients suffering the same disease into a group exposed to a treatment and a control group receiving a placebo.

[4] For an accessible introduction see Guo, S.G. & Fisher, M.W. (2010)

3 METHODOLOGY

3.1 Data

3.1.1 Housing Dataset

The analysis exploits two separate housing datasets that were obtained from the Office of the Victorian Valuer-General (VG). They are the:

- Victoria Property Valuations dataset.
- Victoria Property transactions dataset.

Supplied in a confidentialised format[5], the two datasets provide us with detailed property-level information on sales prices as well as neighbourhood and property characteristics that span a period of more than 20 years[6]. The Property Valuations database is the main source for information on property-level housing, locational and neighbourhood characteristics as at 2008, while the Property Transactions database contains sales information on every sold property in metropolitan Melbourne from 1990–2011.

We merged the two datasets to create a single dataset that matches every sold property's sales information (such as price) with property characteristics like number of bedrooms, age of building and land and floor area, location in relation to principal and major activity centres (areas designated by planning authorities as focal points for employment growth, transport nodes & urban amenities), and planning regulations such as zoning and overlay areas[7]. Table 1 below summaries the key variables contained in the final merged dataset along with their definitions and unit of measurement.

Table 1: List of variables contained in the merged housing dataset

Variable	Definition	Measurement
Sales price	Continuous variable indicating log of the sales price of land plot or property	Nominal Dollars
Number of bedrooms (log)	Continuous variable indicating number of bedrooms contained in each sold property	Log of Number of Bedrooms variable
ICSEA score	Index of Community Socio-Educational Advantage (ICSEA), a continuous variable representing the socioeconomic profile of secondary school's catchment area[8]	Linear value
Age of building (log)	Continuous variable indicating the age of the building in years	Log of Age of Building variable

[5] This database was originally developed under AHURI project titled 'Planning reform, land release and the supply of housing', by Goodman, R., Buxton, M., Chhetri, P., Taylor, E. and Wood, G. (2010), to analyse land use planning policies. We are grateful to Elizabeth Taylor who was responsible for the original design and creation of the merged dataset.

[6] See the Positioning Paper for a more detailed discussion of data sources and how our two main data sets were merged.

[7] The overlay boundaries are identified using VicMap database 2010 version.

[8] Each property transaction is located in relation to its nearest public secondary school and is assumed to belong to the catchment area of its nearest school. It is then matched with the corresponding ICSEA index value.

Variable	Definition	Measurement
Statistical Local Area (SLA)	Vector of dummies indicating the statistical local area that each property transaction belongs to	Equal to 1 if property is in SLA *x*, zero otherwise
Distance to CBD (log)	Continuous variable indicating distance from property *i* to the CBD	Log of distance to the CBD in km
Distance to train station (log)	Continuous variable indicating distance from property *i* to the nearest train station	Log of distance to nearest train station in km
Distance to activity centre (log)	Continuous variable indicating distance from property *i* to the nearest principal or major activity centre	Log of distance to nearest activity centre in km
Distance to primary school (log)	Continuous variable indicating distance from property *i* to the nearest state primary school	Log of distance to nearest primary school in km
Distance to secondary school (log)	Continuous variable indicating distance from property *i* to the nearest state secondary school	Log of distance to nearest secondary school in km
Land size (squared metres) (log)	Continuous variable indicating the area of land plot	Log of the size of the land plot in square metres
Rural zone dummy	Dummy variable indicating properties located in area that is zoned for rural development	Equal to 1 if the property is in an area zoned as residential, zero otherwise (omitted category)
Residential zone dummy	Dummy variable indicating properties located in area that is zoned for residential development	Equal to 1 if the property is in an area zoned as residential, zero otherwise
Industrial zone dummy	Dummy variable indicating properties located in area that is zoned for industrial development	Equal to 1 if the property is in an area zoned as industrial, zero otherwise
Business zone dummy	Dummy variable indicating properties located in area that is zoned for commercial/business development	Equal to 1 if the property is in an area zoned as commercial/business, zero otherwise
Other zone dummy	Dummy variable indicating properties in an area that is zoned for other land uses (e.g. public use zone, comprehensive development zone etc.)	Equal to 1 if the property is in an area zoned as comprehensive development zone, road zone, public park and recreation zone and special use zone, zero otherwise
Environmental significance overlay dummy	Dummy variable indicating properties with environmental significance	Equal to 1 if land is in area regarded as environmentally significant, zero otherwise

Variable	Definition	Measurement
Land subject to inundation overlay dummy	Dummy variable indicating property in an area prone to flooding	Equal to 1 if land is in flood area, zero otherwise
Heritage overlay dummy	Dummy variable indicating areas regarded as places of natural, historical or cultural significance	Equal to 1 if land is in heritage area, zero otherwise

An important caveat to the merged dataset is that the valuation dataset released to us is confined to land and buildings in metropolitan Melbourne, while the transactions dataset contains Victoria-wide sales records. This means that transaction records for properties lying outside of metropolitan Melbourne cannot be matched with property and neighbourhood characteristics, and are consequently omitted from the final merged dataset. This has an important implication for the study design as it restricts neighbourhood renewal (NR) evaluation to those sites located in the metropolitan region.

3.1.2 Neighbourhood Renewal Areas and property transactions

A critical step in the data construction phase was to enhance the housing dataset so that it would include explanatory variables that would identify all properties that are located in the immediate vicinity of an NR site. To be able to do this, we first identified the street-level location and boundaries of each neighbourhood renewal site in metropolitan Melbourne[9]. Across Victoria 21 projects have been progressively launched since 2001, with 11 project sites located in metropolitan Melbourne and 10 project sites in regional Victoria. With the final housing dataset confined to metropolitan Melbourne, our analysis omits project sites in regional Victoria. Among the metropolitan sites Collingwood, Fitzroy, Atherton Gardens, East Reservoir and Flemington are also left out of the sample frame; the Collingwood and Fitzroy NR sites each contain 100 per cent public housing and were therefore excluded from the sample[10]; the East Reservoir NR site had too few property transactions to derive an estimate; and the Flemington site could not be analysed because NR was initiated late in the study timeframe, leaving too few post-treatment years for robust estimation of impacts. This leaves a sample frame covering 8 neighbourhood renewal sites, just under 50 per cent of the state government's NR program. Table 2 presents a list of the sample frame NR sites, the year NR commenced and the statistical local area[11] (SLA) it is located within.

Table 2: List of NR sites analysed

Year of NR program commencement	NR sites (Area)	Statistical Local Area (SLA)
2002	Braybrook (Braybrook and Maidstone)	Maribyrnong
	Ashburton (Ashburton, Ashwood and Chadstone)	Boroondara and Monash
2003	Broadmeadows	Hume

[9] We would like to thank Olwyn Redshaw and Mark O'Driscoll from the Victorian Department of Human Services for their assistance.

[10] Percentage figures on the extent of public housing stock within NR sites were supplied by the Department of Human Services. We are grateful to Moy Lam and Dianne Hill for their assistance.

[11] A Statistical Local Areas is the ABS census definition of an area that comprises one or more Collection Districts (CD). When aggregated, SLAs cover, without gaps of overlaps, the whole of Australia.

Year of NR program commencement	NR sites (Area)	Statistical Local Area (SLA)
	Werribee (Heathdale)	Wyndham
	Doveton- Eumemmerring	Casey
	West Heidelberg	Banyule
2006	Hastings	Mornington Peninsula

GIS tools have been used to create map layers that delineate the boundary of each neighbourhood renewal site. The housing dataset was imported into MapInfo Professional[12] via the latitude and longitude fields and a series of indicator variables were created to identify all property transactions lying within the boundaries of neighbourhood renewal sites; these properties form a 'treatment' sample containing transactions in privately owned housing units directly exposed to the neighbourhood improvements and upgrades executed in their immediate vicinity[13].

Figure 2 illustrates the treatment sample's derivation. The dark border denotes the NR project site boundaries[14]; the orange circles represent privately owned dwellings and vacant lots that are located within each project site and have been sold at least once from 1990–2001; the white circles identify privately owned dwellings and vacant lots that have never been sold over the sample period; and the green circles denote public housing that benefit from rehabilitation. Because we can only observe the prices of properties represented by the orange circles, the estimates of price premiums due to NR are based solely on the sales records of privately owned properties that have been transacted. In arriving at estimates of aggregate non-shelter benefits we assume properties not sold over the sample period benefit to the same degree.

[12] MapInfo Professional is a mapping and geographic analysis application produced by Pitney Bowes Software.

[13] These direct benefits of the NR program ignore any 'spillover' effects beyond the boundary of neighbourhood renewal sites. In Section 4.3 we address this issue.

[14] This treatment sample captures the direct benefits of the NR program; it ignores any indirect or 'spillover' effects that may result from the program. A separate treatment sample will be reported in the Final Report that will also determine the indirect effects of the program.

Figure 2: Identification of NR sites and the selection of treatment group

Neighbourhood Renewal Site X (Treatment Group)

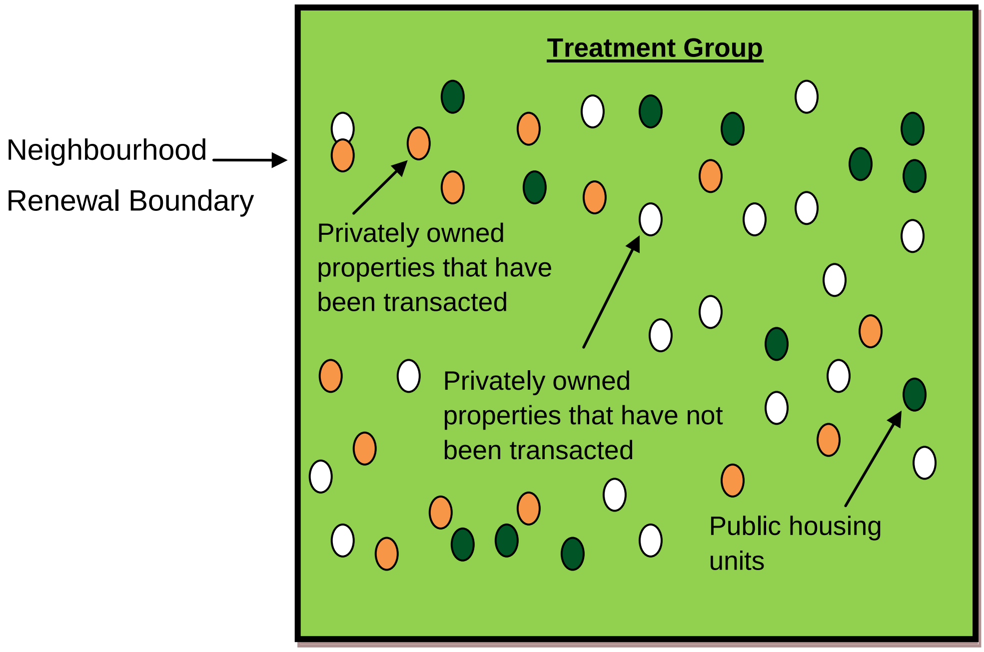


Table 3: Number of transactions within NR sites

NR site	Year of NR program commencement	No. of transactions Pre-NR	Post-NR	Total
Braybrook (Braybrook & Maidstone)	2002	1223	1173	2396
Ashburton (Ashburton, Ashwood & Chadstone)		1140	804	1944
Broadmeadows	2003	614	554	1168
Werribee (Heathdale)		2107	1631	3738
Doveton-Eumemmerring		2021	1435	3456
West Heidelberg		453	137	590
Hastings	2006	70	108	178

3.1.3 Identification of the Control Sample of Properties

To identify an appropriate comparison group, we first constructed a separate baseline control sample for each NR site comprising all properties and land plots that belong to the same SLA as the individual neighbourhood renewal sites under analysis. For instance, the baseline control sample for the Maidstone/Braybrook NR site comprises all properties and land plots located within the boundaries of the SLA that it belongs to, namely, the Maribyrnong SLA. Similarly, the baseline control sample for Broadmeadows comprises properties and land plots within Hume's SLA boundaries (see AHURI Positioning Paper No. 151 for a detailed outline of the baseline sample construction). The SLA is assumed to have uniform housing market characteristics.

To ensure that the comparison group excludes properties that might be impacted by NR programs, those located within 1500 feet of the boundary of NR sites were omitted from the baseline control sample. Their omission is made on the grounds that NR impacts may ‘spill over’ to locations adjacent to but beyond site boundaries. Figure 2 presents a hypothetical SLA (in the form of a circle) from which the control sample is drawn; the SLA is represented by the outer ring; the purple space identifies the area within 1500 feet of an NR site; the green dots denote property transactions that are removed from the baseline control sample because of their proximity to NR sites; the red dots represent transactions in property and land parcels that form the treatment group. Yellow dots are transactions in property and land parcels that are outside the NR site boundaries and its immediate vicinity but still within the same SLA (the baseline control sample). The yellow dot transactions will in all likelihood represent properties with different bundles of housing characteristics. We wish to select those that are as comparable as possible to the treatment sample. To achieve this we use a propensity score method that optimally matches red circle transactions with comparable yellow circle transactions based on their property and neighbourhood characteristics. Table 4 presents the number of property and land transactions within NR-specific baseline control samples.

Figure 3: Selection of the baseline control sample

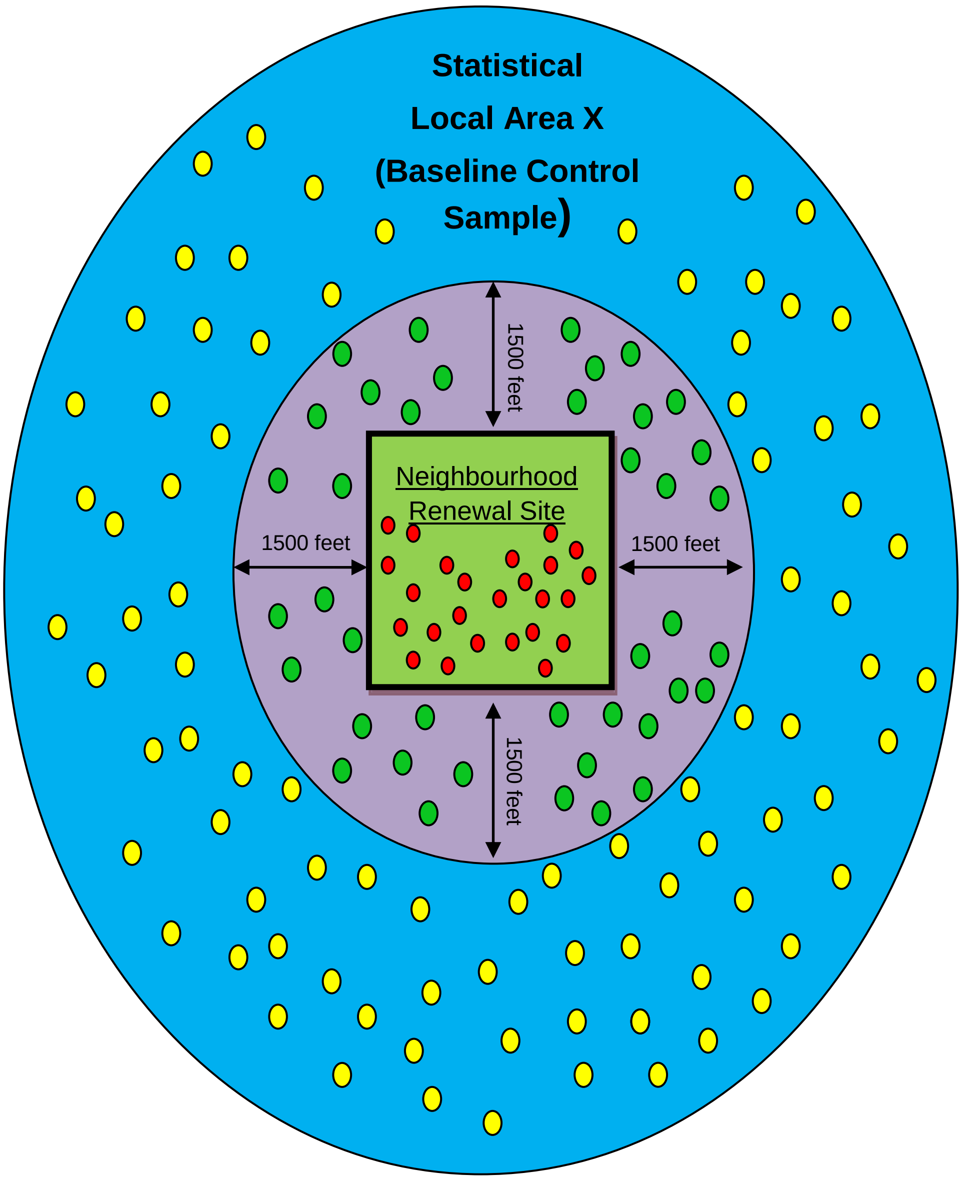


Table 4: Number of transactions within individual baseline control samples

NR site	SLA name	No. of transactions within SLA
Braybrook (Braybrook & Maidstone)	Maribyrnong	16 297
Ashburton (Ashburton, Ashwood & Chadstone)	Boroondara - Camberwell S. and	4848
	Monash–Waverley West	12 638
Broadmeadows	Hume–Broadmeadows	17 083
Werribee (Heathdale)	Wyndham–North; and	6465
	Wyndham–West	12 170
Doveton–Eumemmerring	Casey–Hallam	13 107
West Heidelberg	Banyule–Heidelberg	9705
Hastings	Mornington Peninsula–East	2617

3.2 Empirical Strategy

To obtain a precise estimate of the direct effects of NR schemes, it is essential that an appropriate counterfactual control sample—one that is comparable with properties that are directly exposed to NR (treatment sample)—is selected, and a robust estimation technique is chosen to measure impacts. Our approach combines a propensity score matching method with a difference-in-difference regression model. The former is a technique used to design a suitable control sample of property transactions from the baseline control sample. Once a suitable sample design is obtained via the propensity score matching technique, a difference-in-difference regression model is used to measure the impact of NR.

Propensity score matching method

The validity of quasi-experimental approaches is conditional on identification of a control group that is statistically equivalent to the treatment sample in all ways save for the treatment. Originally developed by Rosenbaum and Rosen (1983), propensity score techniques simultaneously match two groups with respect to multiple variables using a single index. It is called the propensity score, which is an estimate of the conditional probability that any property or land parcel within the relevant baseline control sample is 'exposed' to neighbourhood renewal. Thus, the propensity score summarises an n-dimensional vector of property characteristics in a single index, and thereby simplifies matching when there is more than one characteristic distinguishing those exposed to treatment[15] (Becker & Ichino 2002).

The conditional probabilities can be estimated using regression methods with the dichotomous treatment variable (indicating whether the property transaction is within the boundaries of an NR area) as the dependent variable, and observable property and neighbourhood characteristics as regressors. We apply a probit regression model to estimate the conditional probabilities/propensity scores.

[15] Suppose there were only one characteristic, (say) income. Treatment and controls group can then be easily matched; for each member of the treatment group we find the member of the baseline control (those residing in the same neighbourhood but outside the NR area boundaries) that has the nearest income.

When estimating the propensity score, it is important to include in the model all relevant regressors that could affect both selection into the treatment group and the outcome (i.e. property price premiums) of interest (Heinrich et al. 2010). This includes property-level characteristics like number of bedrooms, floor area, age of building and land area, as well as amenity and neighbourhood characteristics like distance to train stations, distance to the CBD, ICSEA value, distance to schools and activity centres.

Once the propensity score is obtained, we use it to carry out two types of regression adjusted methods to estimate causal effects:

- regression-adjusted matching method
- weighted regression adjustment method.

In the first regression-adjusted matching method, the nearest neighbour algorithm with replacement is used to select a control group. For any treatment property, the property outside the treatment area with the nearest propensity score is selected as the control. Once the control sample design is selected, a post-estimation t-test is performed to assess whether we can reject the null of no statistically significant differences in property characteristics. If the null can be rejected, we go back and estimate an alternative specification of the probit model, and reapply the nearest neighbour algorithm until the balancing property is fulfilled (i.e. t-tests fail to reject the null of no statistically significant differences)[16].

A difference-in-difference regression model is then estimated. The difference-in-difference regression model controls for covariates that are excluded from the propensity score model because they failed to balance. However we also include the regressors used in the probit regression; this results in a 'doubly-robust' estimate (Shadish et al. 2002).

In the second weighted-regression adjusted method, the propensity scores are used to re-weight observations in the baseline control sample by the inverse of the propensity score (Imbens 2000). One of the appealing properties of weighting is that it includes all the data (unless weights are equal to 0). Accordingly, we apply a second difference-in-difference regression model where the propensity score is used to re-weight control observations.

The difference-in-difference model (separately for each NR site) regresses the log of house price on neighbourhood characteristics, property-level characteristics, year/quarter time dummy variables, a time trend, postcode dummy variables, and dummy variables representing properties within the boundary of an NR site. Specifically, this hedonic regression takes the following form:

$$Y_{it} = \alpha + \sum \beta_t S_{it} + \sum \delta_k C_{ik} + \sum \gamma_t Q_{it} + \omega T_t + \lambda DTreatment_{it} + \phi DTreatment_{it} * DPost_{it} + \varepsilon_{it}$$

Where: Y_{it} is the log of the per unit sales price of property *i* in period *t*; *Sit* is a vector of property-related characteristics and includes number of bedrooms, size of the land parcel and age of the building; C_{ik} is a group of time invariant structural and locational characteristics; Q_{it} represents a set of annual dummy variables with year 1990 representing the base period; and T_t represents the log value of a continuous quarterly time trend variable that equals 1 if property *i* is sold in quarter 1 in year 1990, 2 if sold in quarter 2 of year 1990 etc. Variable $DTreatment_{it}$ is a dummy variable identifying

[16] Alternative specifications of the probit model commonly involve the addition of squared values of the continuous regressors and interactions between dichotomous and continuous variables.

property transactions that are located within the boundaries of a neighbourhood renewal site that was introduced in year t. Variable *DPost*$_{it}$ is a dummy variable that flags transactions that had taken place after the NR scheme was introduced in year *t*. The intercept is α, the coefficient ω captures underlying trend changes common to all property values, while the coefficient γt will measure deviations from trend in any one year. The coefficient on *DTreatment*$_{it}$, λ, measures the location effect that is not due to the introduction of NR. The parameter of particular interest is Φ, the effect of the interaction term *DTreatment*Dpost* : Φ estimates the change in property values due to the NR scheme[17].

In another variant of this model specification (Model 2), we allow the difference in differences (or average treatment effect) coefficient (ϕ) to vary across calendar years in the post-treatment era. Finally, ε_{it} it is an error term that is assumed to be normally distributed with an expected value equal to zero, and constant variance.

[17] Strictly speaking the coefficient Φ is not the simple difference in differences estimator that is obtained from an OLS regression without controls, but it has a similar interpretation (see Wooldridge 2001).

4 RESULTS

We begin this chapter by presenting and discussing our findings on the size of externality benefits within each of the neighbourhood renewal (NR) sites. We then turn to possible impacts outside the boundaries of NR areas, so called spillover effects. The sensitivity of estimates to an alternative internal control group approach is explored before concluding the chapter with a benefit cost analysis of each NR project.

4.1 Estimates of Within Boundary NR Benefits

Regression models have been estimated using the two different control designs described in Chapter 3, and for each of the seven NR sites. In the main body of the report we list findings from a weighted regression-adjusted method where every transaction in the treatment sample and all transactions in the base control (the rest of the SLA within which the NR is located) are weighted by their propensity scores (see page 21). Similar results consistent with the study's conclusions are obtained using a nearest neighbour algorithm control design (see Appendix A4 & A5).

Table 5 lists the coefficient estimates for key variables as obtained from the difference-in-difference model specification in Equation 1. In the first column NR areas are presented in the same order as their date of introduction; the year of the NR's launch is recorded in column two. The substantive table content is then presented in the next two columns; our variable *DTreatment* captures deviation in house prices between NR zones and the control before NR interventions. It confirms that house prices within the boundaries of targeted NR projects were on average below those of properties in the control sample in all but one (West Heidelberg) of the NRs. The variable *DTreatment**Post measures the divergence in house prices between NR areas and control samples after the commencement of the NR program. We find that NR is the source of a statistically significant price premium favouring private housing transactions within the boundaries of five NR areas. In one NR project (Doveton) there is no statistically significant difference in housing prices as compared to the control sample. Finally, there is one NR area (Werribee) where a statistically significant and negative price premium is obtained.

We might expect price premiums to vary by launch date, with NR interventions introduced later in the sample time frame (1990–2011) having smaller price premiums because post-intervention periods are shorter and non-shelter benefits might take time to emerge, but there are few signs of this in Table 5. Broadmeadows and Hastings, for instance, have similar price premiums despite the former NR program commencing 3 years earlier. The final two columns report sample numbers and a 'goodness of fit' R2 statistic that can range between 0–1. Sample numbers are invariably healthy, with only one NR area dipping below 5000 transactions (Hastings). With a time trend and wide range of controls for property, neighbourhood and amenity characteristics (see Appendix A2), and high R2 goodness of fit statistics are achieved.[18]

[18] A large number of control variables are added to the regression model specification that includes the use of calendar time variables to captures trend increases in house prices and deviations from trend as advocated by Galster et al. 2004 (the adjusted interrupted Time Series Model). Coefficient estimates and annual time dummy estimates can be found in appendix A2 and A3, respectively.

Table 5: Key findings from DID specification-weighted regression adjustment method

NR area	Cohort	DTreatment	DTreatment* Post	No. of obs.	R-squared
Maidstone	2002	-.103 (.022)***	.035 (.0176)*	14 020	0.8530
Ashburton	2003	-.214 (.034)***	.074 (.032)**	18 836	0.8641
Broadmeadows	2003	-.095 (.021)***	.139 (.016)***	18188	0.9028
Doveton-Eumemmerring	2003	-.194 (.021)***	-.003 (.013)	14 973	0.7613
Werribee (Heathdale)	2003	-.067 (.020)***	-.052 (.016)	20 986	0.6466
West Heidelberg	2006	.054 (.079)	.129 (.031)***	8197	0.8578
Hastings	2006	-.293 (.095)***	.160 (.071)**	2795	0.7073

Note: Standard errors in parentheses * denotes coefficient statistically significant at 10%, two-tailed test; ** denotes coefficient statistically significant at 5%, two-tailed test; *** denotes coefficient statistically significant at 1% level, two-tailed test.

Table 6 translates the price premium coefficients into a percentage increase[19] (column 3), and uses the price premium as the basis for computing an aggregate measure of externality (non-shelter) benefits within the boundary of each NR area. This measure of total externality benefits is a key estimate; it is arrived at by selecting each post-NR intervention private housing transaction and calculating the product of the transaction price and percentage price premium. This dollar figure is then expressed at 2011 prices by indexing using the CPI and summed over all transactions. It is assumed that price premiums are uniform across the NR private housing stock; the inverse of private housing transactions as a proportion of the total private housing stock is employed to aggregate across the entire private housing stock within NR boundaries. The results are the estimates in column 5, Table 6.

In the NR areas where price premiums are found to be positive, externality benefits sum to $372m at 2011 prices. Unsurprisingly, benefits tend to be bigger where the private housing stock is larger. Ashburton reflects this most strongly with benefits that sum to $182m, nearly half of the total across all NR areas. But the size of the private housing stock is not the only factor. The NR program in Broadmeadows is able to generate higher aggregate benefits than Maidstone despite a smaller private housing stock. It seems that price premiums are much higher in Broadmeadows, and it has a bigger concentration of public housing which would tend to magnify the impact of upgrades to public housing units. Price premiums are also relatively high in West Heidelberg where the NR project is again implemented against a backdrop featuring a high concentration of public housing.

[19] The percentage impact estimates for binary variables (when the dependent variable is a natural logarithm) are calculated from (e^{β} - 1), where β is the estimated coefficient (see Halvorsen & Palmquist 1980).

Table 6: Price premiums and aggregate benefits

	Cohort	Price premium	Total private housing stock within NR site(units)[1]	Aggregate benefit (2011 prices)	Average price post intervention (2011)	% of public housing
Maidstone	2002	4%	3624	$51.3m	$269 350	21.2
Ashburton	2003	8%	4260	$182.1m	$413 703	19.9
Broadmeadows	2003	15%	1286	$55.1m	$228 270	30
West Heidelberg	2006	14%	329	$17.4m	$290 686	48.9
Hastings	2006	17%	1683	$65.8m	$201 185	14.5

Note: 1. The total number of private housing units. The total number of housing units within each NR area has been identified using the merged Valuer General data set and Mapinfo (see Chapter 3); from the total we have subtracted the number of public housing units, a percentage figure we obtain from the Department of Human Services. We are grateful to Moy Lam for assistance in this regard.

The price premiums attributable to NR will generate additional stamp duty revenues. This potentially important return to government 'coffers' is estimated in Table 7; it is arrived at by again selecting each post-NR intervention private housing transaction and converting the prices at sale dates to 2011 values using the CPI. The 2011 Victorian state government stamp duty schedule is applied to estimate stamp duty liabilities[20]. A hypothetical stamp duty is estimated by subtracting the NR price premium to generate the counterfactual sale price in the absence of NR. The difference between the two stamp duty estimates is our measure of additional stamp duty revenue. These calculations indicate that total stamp duty revenues increase by $5.3m. As expected, they are larger in NR areas where the number of post-intervention housing transactions is high (e.g. Ashburton) and/or areas where price premiums are large (e.g. Broadmeadows).

Table 7: Stamp duty gains

	Cohort	No. of transactions in the NR housing stock (post NR period)	Stamp duty revenue with NR	Stamp duty revenue in absence of NR (2)	Increase in stamp duty revenue due to NR (2)
Maidstone	2002	1173	$27.9m	$27.0m	$0.99m
Ashburton	2003	804	$27.9m	$25.9m	$2.0m
Broadmeadows	2003	554	$10.9m	$9.5m	$1.4m
West Heidelberg	2006	137	$3.2m	$2.8m	$0.40m
Hastings	2006	108	$1.8m	$1.3m	$0.47m

[20] The identity of buyers is unknown and so concessions to first home buyers and the higher rates applicable to investor purchases cannot be taken into account.

4.2 Benefit Cost Analysis

The Victorian State Government's Department of Human Services has released expenditure budgets for each NR area[21]. Each NR budget lists total budget spending in each calendar year since its introduction. In the NR areas where we find positive price premiums total program expenditure varies from a high of $57m in Maidstone to a low of $8m in Hastings. There is a relatively small program in Hastings that did not start until 2006, and hence some of its expenditure budget has yet to be spent. These figures differ from the historic cost numbers because we have converted outlays in each financial year to 2011 prices[22]. Conversion to 2011 price levels ensures that both externality benefits and expenditures are expressed at the same year's price level. There are two caveats with respect to the cost figures. Firstly, the outlays include all spending on public housing units including items for activities such as routine maintenance that would have been incurred in the absence of NR action plans. Secondly, there are other service delivery agencies (e.g. health, education) that could have invested in NR programs/areas to generate synergies from the integration of services, an important component of the strategy (see Chapter 2). Estimates of these cost outlays by other agencies are not available.[23]

Table 8: Cost benefit analysis, results

NR site	Cohort	Aggregate benefits (2011 prices)	Total expenditure[1] (2011 prices)	Benefit/cost ratio	Capital spending as % of all outlays
Ashburton	2003	$182.1m	$14.4m	12.6	67%
Hastings	2006	$65.8m	$8.0m	8.2	68%
Broadmeadows	2003	$55.1m	$16.3m	3.4	73%
West Heidelberg	2006	$17.4m	$10.2m	1.7	68%
Maidstone	2002	$51.2m	$57.0m	.90	94%
Werribee	2003	-$90.7m	$11.8m	-7.7	59%
Sub-Total	NR	$280.9m	$117.7m	2.38	74%
Doveton	2003	No statistically significant benefits detected	$12.0m	-	66%
Total	**NR**	**280.9**	**129.7**	**2.2**	**71%**

Note: 1. Total expenditures in each financial year from the NR program's introduction to 2010-'11; financial year cost outlays have been converted to 2011 prices.

Table 8 summarises the results from a benefit cost appraisal. We first consider those NR programs with statistically significant price premiums. For these five NR areas we estimate benefit-to-cost ratios that range from a high of $13 for each dollar spent in Ashburton, to just under $1 per one dollar spent in Maidstone. Ashburton happens to be

[21] We are grateful to Moy Lam and Dianne Hill for their assistance in providing these figures.

[22] For example, in Maidstone/Braybrook the historic cost measure produces a total expenditure of $47.8 m, but when converted to 2011 prices this is equivalent to $57.0 m.

[23] This would be a particularly important point to note in relation to community infrastructure projects. Though a relatively small component (relative to capital budgets for the upgrade of public housing units) of NR action plans, internal NHS documents suggest that for every $1 invested by Victorian Department of Human Services in 2010-11, $8 was leveraged from other partners.

distinctive because of a relatively light emphasis on capital spending (67% of total), and a relatively heavy focus on employment and community infrastructure services (grants) at 18 per cent of the total expenditure budget. In these 5 NR areas we estimate that every dollar spent is responsible for the generation of $3.5 of housing externality benefits. But there are two NR areas where housing externality gains are not detected. When we add these sites and their costs into the benefit-cost equation our measure remains a positive multiple with externality gains of $2.2 for every dollar invested in NR areas over a nearly 10-year period 2002–11. Rossi-Hansberg, Sarte and Owens (2010) estimate that neighbourhood revitalisation programs in Richmond, Virginia generate housing externality gains that range between $2–6 per dollar invested in the program over a 6-year period. Our own estimates are also in this range.

4.3 Spillovers Benefits

Studies in the United States such as those of Santiago et al. (2001) and Schill et al. (2002) investigate housing externality gains with respect to dispersed neighbourhood renewal sites; the site could be an apartment building or high rise public housing building that is the subject of rehabilitation/upgrade, or even demolition and rebuild (as is common with HOPEVI, see Levy 2012). The geography characterising these interventions is dissimilar to the kind of broad acre NR areas typical of the Victorian metropolitan program, where concentrations of low rise public housing are interspersed within area boundaries containing ample amounts of private housing[24]. For dispersed sites US researchers identify housing externalities by drawing a circle around the apartment or high rise public building, and using the property values of private transactions within that radius as a 'treatment' sample. Schill et al. (2002), for example, identified all properties that were within 500 feet of housing units built or rehabilitated as part of neighbourhood renewal programs (treatment group), and compared them to properties that were located more than 500 feet from investment sites, but still in the same neighbourhood (control group). On the other hand, Santiago et al. (2001) defines the treatment group as all properties within 2000 feet of a dispersed housing site. To detect whether impacts vary the authors create a series of 'neighbourhoods' centred on dispersed housing sites, each one comprising one of several concentric rings: 0–500 feet, 501–1001 feet, and 1001–2000 feet from the site.

Though Victorian NR programs are typically implemented in mixed private/public areas rather than individual high rise buildings, housing externality gains might nevertheless spillover beyond their boundaries. We follow Colwell, Dehring and Lash (2000) and draw a radius that is 1500 feet from the nearest point on the NR area's boundary (see Figure 2). We now define the treatment sample as comprising all housing transactions outside the NR boundaries, but within the 1500 feet radius. Housing transactions within the NR area boundaries are omitted. The base control design remains properties located outside the 1500 feet radius, but still in the same Statistical Local Area. Nearest neighbour and weighted regression adjusted methods have again been employed as matching techniques for implementation of the propensity score approach. Conclusions are unaffected by choice of which estimates to present; the key coefficient weighted regression adjusted method estimates are reported in Table 9 below[25]. As housing externality effects from NR are expected to be weaker beyond the boundaries of NR areas we have employed larger sample sizes by estimating regressions for each 'cohort'

[24] The NR area of Collingwood is more typical of the US studies referred to, as it is a site with 100% high rise public housing.

[25] Results from use of the nearest neighbour matching algorithm are similar; results available for authors on request.

of NR programs, that is those introduced in 2002 (Collingwood[26] & Maidstone) are analysed together and similarly for the 2003 (Broadmeadows, Doveton & Werribee) and 2006 (Hastings & West Heidelberg) cohort of NR areas. The same difference in difference regression model specification (with controls) is employed as in measurement of within boundary effects.

Table 9: Spillover effect estimates, weighted regression adjusted method

Variables	2002	2003	2006
Ring 1	-.138	-.058	-.142***
	(.011)***	(.012)***	(.031)
Ring 2	-.107	-.026	-.156***
	(.011)***	(.010)**	(.032)
Ring 3	-.070	-.003	-.101***
	(.009)***	(.007)	(.025)
Ring 1*Post	.003	.057***	.129***
	(.015)	(.016)	(.046)
Ring 2*Post	.023	.051***	.227***
	(.015)	(.014)	(.050)
Ring 3*Post	-.038***	.024**	.116***
	(.012)	(.010)	(.036)
No. of observations	26 622	74 549	14 283
R-squared	0.8196	0.7552	0.7668

Note: Ring 1 is within 0feet-500feet of NR boundary; ring 2 is within 500feet-1000feet of boundary; ring 3 is within 1000 feet–1500 feet of boundary. Standard errors in parentheses * denotes coefficient statistically significant at 10%, two-tailed test; ** denotes coefficient statistically significant at 5%, two-tailed test; *** denotes coefficient statistically significant at 1% level, two-tailed test.

The variables ring 1, ring 2 and ring 3 define a radius that is 500 feet, between 500 feet and 1000 feet and between 1000 feet and 1500 feet (respectively) from the nearest point on NR boundaries. Coefficient estimates indicate that prices within these rings are lower than controls formed from the rest of the SLA, and in all but one case these differences are statistically significant. As we move from the nearest adjacent ring to more distant rings the negative price differential narrows. The variables ring1*post, ring2*post and ring3*post interact the ring indicators with a post dummy variable that flags transactions following the introduction of NR boundaries. They are therefore designed to detect any positive spillover effects. In the two NR areas comprising the 2002 cohort, price premiums are positive in two of the three rings, but statistically insignificant. Furthermore ring three effects turn out to be negative and statistically significant, contrary to expectations. A consistent set of positive findings is apparent for the 2003 cohort of NR areas. Price premiums of between 5.8 per cent (in ring 1) and 2.4 per cent (in ring 3) are revealed, with premiums monotonically declining with more distant rings. Spillover effects are strongest among the 2006 cohort of NR zones (West Heidelberg & Hastings), with price premiums ranging from 25.5 per cent (ring 2) to 12.3 per cent (ring 3).

[26] Housing externality gains within NR boundaries were not examined in the case of Collingwood because it is similar to those US neighbourhood revitalisation sites, where high rise public housing is targeted and there is no private housing contained within the boundaries of the NR area.

4.4 The Revealed Preference Approach

The sensitivity of our estimates to alternative approaches has been investigated using a revealed preference methodology. This approach exploits the staggered introduction of NR areas in the Melbourne metropolitan region, and assumes that those areas commencing later in the study period are as equally disadvantaged as areas with earlier commencement dates. Since NR areas are chosen using the same selection criteria this assumption has some credibility; it can be used to justify the use of later NR areas to form an 'internal control' sample of properties that is comparable to treatment samples formed from NR areas with an early start date. The revealed preference approach relies on the use of uniform program selection criteria to achieve the same control group sample design task that propensity score matching aims to achieve.

But there is a limitation; to form a suitable control group we must restrict the sample of property transactions to a period before the start of NR areas that are launched toward the end of our sample period. The later NR areas (Hastings & West Heidelberg) begin in 2006, and our earliest NR areas were begun in 2002. This still leaves a study time frame 1990–2005, but only three years of that time frame when NR had commenced in the 2002 cohort of programs but had yet to begin in the 'internal controls'. This limitation results in an unbalanced sample; there are 1563 transactions (or 69% of the total 2265 sample) sourced from the pre-2002 period, but only 702 transactions (or 31% of the total 2265 sample) from 2002–05 when NR had started in the treatment sample. This imbalance could mask significant impacts, particularly if the effects of NR gradually accumulate with some impacts delayed until after 2005[27]. In the 2003 cohort of NR areas there is an even shorter window of time over which post-NR impacts can be detected, and such an unbalanced sample and short post-NR time period prompted us to restrict application of this approach to the 2002 Maidstone NR area only.

The differences in difference model estimates are reported in Table 10. The model departs from earlier specifications in two ways. Firstly, the treatment of time in earlier models includes both a quarterly time trend and calendar year dummies (Galster et al. 2004). In the shorter time frame this proved unsuccessful[28]; we dropped the time trend and included just the calendar year dummies. Second, we also experimented with alternative treatment variable definitions given concerns that NR impacts might gradually accrue and our post-treatment time frame is short. In the first of two models reported below, we retain the key *Dtreatment**Post variable used to detect NR effects on property prices; in this form we are assuming that NR causes a 'once-and-for-all' shift in house prices that is uniform and sustained over the post-NR period. But in a second model we interact *Dtreatment**Post with each of the calendar year dummies covering the post treatment period 2002–05. This allows impacts to vary over the post-NR period.

We report linear model estimates in Tables 10 and 11 of these alternative specifications. A positive impact on post-NR house prices is detected in Table 10, but it is statistically insignificant. Table 11 reports estimates when we interact *Dtreatment**Post with each of the calendar year dummies. In 2002, 2003 and 2004 positive impacts are detected, and in two of these years coefficient estimates are statistically significant.[29] However, in the final year (2005) of the sample time frame negative impacts are detected (statistically significant at 10%). By this time property transactions in the control could already be

[27] This is likely; in the case of Maidstone only 50% of total programme outlays have been spent by 2005.

[28] The time trend coefficient was insignificant, and most of the calendar year dummies were also insignificant.

[29] With a linear specification the statistically significant coefficients suggest that house prices are lifted by $13 190 in 2002 and $25 485 in 2004.

‘contaminated’ by the announcement and imminent roll out of NR action plans in West Heidelberg and Hastings, and could therefore account for this finding.[30]

The revealed preference approach with its use of internal control groups is in principle a promising methodology, but in practice requires a longer post-NR treatment time frame than is possible here. Though some positive impacts are detected the practical limitations warrant caution. The propensity score methodology offers a more reliable guide in the circumstances.

Table 10: Revealed preferences (Model 1)

NR Area	Cohort	DTreatment	DTreatment*Post
Maidstone	2002	-4957.4	6791.1
		(9946.0)	(4960.7)
No. of observations	2265		
Adjusted R-squared	0.7644		

Note: Standard errors in parentheses

Table 11: Revealed preferences (Model 2)

NR Area	DTreatment	DTreatment *Post*2002	DTreatment *Post*2003	DTreatment *Post*2004	DTreatment* Post*2005
Maidstone	-6311.5 (9936.5)	13 189.8 (6970.4)*	11 265.3 (7307.6)	25 484.7 (7664.9)***	-12 953.5 (7666.8)*
No. of observations	2265				
Adjusted R-squared	0.7664				

Note: Standard errors in parentheses * denotes coefficient statistically significant at 10%, two-tailed test; ** denotes coefficient statistically significant at 5%, two-tailed test; *** denotes coefficient statistically significant at 1% level, two-tailed test.

[30] It should also be noted that spending in these two NR areas commenced in fiscal year 2005–06 ($201 000 in Heidelberg & $149 000 in Hastings).

5 CONCLUDING COMMENTS AND FUTURE DIRECTIONS FOR RESEARCH

This project designs and implements a quasi-experimental methodology for the evaluation of urban renewal programs. The approach rests on the key insight that if neighbourhood renewal reverses negative externalities such as crime and vandalism, these benefits will generate house price premiums on private housing market transactions within the boundaries of neighbourhood renewal areas. We obtain a financial measure of these Neighbourhood Renewal (NR) housing externality benefits by estimating these price premiums. The estimation method relies on a study design that compares a sample of private housing market transactions in neighbourhood renewal areas with a control group of transactions that is formed using propensity score matching techniques. This is a novel approach in the Australian context and could be used to estimate benefits from a wide range of housing and urban policy interventions.

We find that NR is the source of a statistically significant price premium within the boundaries of five (out of 7) NR areas. The price premium estimates are used as the basis for computing an aggregate measure of housing externality benefits within the boundary of each NR area. In the NR areas where price premiums are found to be positive, housing externality benefits sum to $372m at 2011 prices. Unsurprisingly, benefits tend to be bigger where the private housing stock is larger (and of higher value) within the boundaries of NR areas (e.g. Ashburton); but another factor appears to be bigger concentrations of public housing, which tend to magnify the impact of upgrades to public housing units (e.g. West Heidelberg & Broadmeadows). Ashburton is also distinctive because of a relatively light emphasis on capital spending (67% of total), and a relatively heavy focus on employment and community infrastructure services (grants) at 18 per cent of the total expenditure budget.

In the NR areas where we find positive price premiums total program expenditure varies from a high of $57m in Maidstone to a low of $8m in Hastings (at 2011 prices). Across the five NR areas expenditure outlays to 2010–11 total $106m (at 2011 prices). We therefore estimate that every dollar spent is responsible for the generation of $3.5 of housing externality benefits. But there are two NR areas (Doveton & Werribee) where zero or negative housing externality gains are detected. When we add these sites and their costs into the benefit-cost equation our measure remains a positive multiple with externality gains of $2.2 for every dollar invested in NR areas over a nearly 10-year period 2002–11. A part of the housing externality gains accrue to government as a result of additional revenues from taxes and charges such as stamp duties, land taxes and property rates. We are able to estimate the additional stamp duty revenues; these calculations indicate that total stamp duty revenues increase by $5.3m (at 2011 prices), which represents a modest offset to NR budget outlays. The addition of land tax and property rates revenue gains is an important research question to be addressed in the future.

It is common for advocates of neighbourhood renewal to emphasise an equity rationale for place based interventions, and their role in closing the gap between severely disadvantage communities and the rest. But this overlooks an efficiency rationale. An important aspect of the housing externality gain estimates presented here is their interpretation as a measure of efficiency gains. Neighbourhood renewal can if successful help reverse negative housing externalities that cause the misallocation of resources because of under investment in assets and activities adversely affected by negative externalities. The estimates presented in this report suggest that neighbourhood renewal generally succeeds in that task. But there is a qualification to bear in mind. Non-shelter benefits attributable to NR push up house prices and may therefore exacerbate housing affordability stress. But is this a reasonable claim? Housing affordability stress arises when the rents and prices of housing in neighbourhoods with fixed attributes rise faster than incomes. But the NR related house price premiums reflect improved housing and neighbourhood quality, an important distinction.

The Victorian Government's Department of Human Services (DHS) has been monitoring the impact of its neighbourhood renewal interventions. These evaluations use two main sources of data; a community survey repeated every two years and a yearly administrative data collection. The findings from the administrative and community survey could if unpacked on an NR site basis enrich and complement our own findings. We believe this would be particularly helpful in aiding the interpretation of our price premium findings. These do vary and in one case is negative. It would be instructive to examine the DHS evaluation results on an individual NR basis.

The application of quasi-experimental techniques to Australian property data bases is at an early stage of development. There are a number of refinements that are therefore worthy of consideration in future research agendas because they could increase the precision and reliability of estimates, as well as help gain the confidence of the policy community in their use for both housing and urban policy evaluations:

While the approach has the virtue of providing financial measures of benefits and costs, it does not 'unpack' the benefits measure. Are gains due to falling crime and vandalism, or is it due to gains in employment and incomes as community infrastructure services lift economic participation rates? These are of course important questions. But some progress toward answering such questions could be made by analysing transactions in commercial and industrial property. If NR program improve the quality of local workforces and lift household incomes then local businesses could enjoy productivity gains (and hence improved profitability), and these gains will generate price premiums for commercial and industrial property. Use of transactions in such property can help us to understand the economic gains that may be attributable to NR.

The measures generated in this project rely on the use of housing transactions, but housing is complex and multidimensional. There are numerous characteristics of housing that are unmeasured in property data bases and the Victorian Valuer General database is no exception. Two modifications are possible here; the first is to only use transactions in vacant land, an approach we have used before in a different context (see Cigdem, Taylor & Wood 2011). Vacant land has far fewer quality dimensions and so empirical analysis is less problematic. But observations are fewer in number, and since an objective of the current project was NR specific estimates we eschewed this option. The same reasoning prompted us to spurn use of repeat sales modeling as a technique for measurement of price premiums due to NR. But in a different context these alternative techniques could be more relevant.

The sample of NR areas is drawn from the Melbourne metropolitan area. The regional NR areas are an important extension of the research because local economies in the regions will differ (e.g. be less diversified) and this could affect the success or otherwise of NR. An increase in the number of NR areas studied also opens up more opportunities to investigate how variations in in program content affect the chances of success. We have some indication from the Ashburton NR that a greater emphasis on community infrastructure services and employment services could prove rewarding. But there is much research to be conducted here before what is at present little more than speculation can be converted into confident prediction.

Further refinement of the methodology is worthy of investigation. Specifically, there is room to improve methods for constructing the baseline control sample so that it reflects the treatment sample more closely in spatial terms. For example, the baseline control sample could be confined to a smaller spatial unit than SLA (e.g. postcode-level or suburb-level). Alternatively, we could use GIS tools to create a one kilometer concentric circle around NR sites and extract properties within the circle so that they form the baseline control sample.

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APPENDIX

Probit regression model

We begin this Appendix by providing an example of a probit regression model that is executed for every NR site. Probit regression models are used to estimate propensity scores, where the dependent variable is a property's neighbourhood renewal status and the independent variables are neighbourhood and property characteristics. In this particular example, we use approximately 18 700 observations which make up the treatment and baseline control sample for the Maidstone NR site. Similar probit regression models are applied to other NR project sites to generate propensity scores.

Table A1: Probit regression model for Maidstone NR Site

Distance train station (log)	6.905
	(25.66)**
Distance train stations^2 (log)	-7.327
	(25.16)**
Land area (log)	9.441
	(9.02)**
Land area^2 (log)	-0.683
	(8.08)**
Age of building (log)	2.290
	(8.97)**
Age of building^2 (log)	-0.441
	(11.09)**
Number of bedrooms (log)	-4.275
	(6.58)**
Number_of_bedrooms^2 (log)	1.211
	(3.68)**
Constant	-33.127
	(10.03)**
No. of Observations	18,693

Note: Standard errors in parentheses * denotes coefficient statistically significant at 10%, two-tailed test; ** denotes coefficient statistically significant at 5%, two-tailed test; *** denotes coefficient statistically significant at 1% level, two-tailed test.

Results on covariates

The following table reports the coefficient estimates on all explanatory variables used in the various DID Weighted regression-adjusted model specifications and their level of significance. There are five main categories of explanatory variables that are controlled for in the DID regression. These are:

- property characteristics
- planning overlays
- distance variables
- socioeconomic indicators
- continuous quarterly time trend variable.

Table A2: Results on covariates from DID weighted regression-adjusted specification

Variables	Maidstone	Ashburton	Broad-meadows	Doveton	Werribee	Hastings	Heidel-berg
Property characteristics							
Land area (log)	.060 (.018)***	.066 (.030)**	.053 (.034)	.111 (.027)***	.067 (.028)**	.273 (.152)*	.102 (.045)**
Floor area (log)	.262 (.038)***	.262 (.034)***	.282 (.029)***	.242 (.025)***	.207 (.031)***	.030 (.119)	.196 (.071)***
Number of bedrooms (log)	-.032 (.037)	.120 (.022)***	-.021 (.026)	.025 (.036)	.011 (.045)	.070 (.124)	.026 (.049)
Age of building (log)	.017 (.014)**	.015 (.015)	.051 (.032)	.155 (.014)***	.376 (.014)***	.276 (.080)***	.008 (.020)
Commercial property	.041 (.213)	.075 (.120)	-.367 (.220)*	.238 (.136)*	.890 (.169)***	-.288 (.430)	-.222 (.080)***
Flat/Unit	-.433 (.034)***	-.074 (.016)***	.089 (.043)**	-.215 (.021)***	.201 (.025)***	.561 (.170)***	-.010 (.025)
Undeveloped land	-.218 (.045)***	-.289 (.102)***	Na	.024 (.058)	.755 (.141)***	na	-.023 (.075)
Planning							
Heritage overlay dummy	.021 (.018)	-.005 (.040)	.171 (.072)**	.113 (.162)	.028 (.048)	.395 (.083)***	.293 (.096)***
Environmental overlay dummy	na	na	-.098 (.029)***	Na	-.201 (.061)***	.527 (.181)***	-.150 (.051)***
Inundation overlay dummy	.116 (.025)***	-.013 (.065)	Na	-.050 (.142)	Na	-.337 (.094)***	.266 (.048)***
Distance Variables							
Distance to train station (log)	.142 (.034)***	-.062 (.015)***	.025 (.009)***	-.019 (.020)	-.014 (.046)	115.20 (51.14)**	-.191 (.039)***
Distance to CBD (log)	-.811 (.104)***	-.654 (.060)***	.336 (.157)**	-1.87 (.347)***	.073 (.168)	3.41 (2.50)	-1.43 (.221)***
Distance to activity centre (log)	-.038 (.031)	-.037 (.045)	-.260 (.048)***	.291 (.051)***	.014 (.052)	-115.98 (50.78)**	1.06 (.193)***
Distance to primary school (log)	.014 (.010)	-.040 (.013)***	.018 (.006)***	.009 (.007)	.043 (.008)***	-.103 (.045)**	-.024 (.018)
Distance to secondary school (log)	.037 (.012)***	-.018 (.011)	-.0004 (.007)	-.019 (.008)**	.008 (.013)	-.062 (.126)	-.092 (.043)**
Socioeconomic Indicators							
Reading rank	.137 (.040)***	-.061 (.025)**	-.119 (.026)***	na	.038 (.032)	1.37 (.996)	.004 (.021)

Variables	Maidstone	Ashburton	Broad-meadows	Doveton	Werribee	Hastings	Heidel-berg
ICSEA Value (log)	1.65 (.683)**	-.589 (.440)	.223 (.149)	5.26 (1.74)***	1.01 (.922)	42.78 (25.37)*	-.142 (.942)
Other							
Time (log)1	.068 (.037)*	-.083 (.047)*	.005 (.069)	-.050 (.036)	-.022 (.047)	2.38 (.731)***	-.089 (.087)

Note: Standard errors in parentheses * denotes coefficient statistically significant at 10%, two-tailed test; ** denotes coefficient statistically significant at 5%, two-tailed test; *** denotes coefficient statistically significant at 1% level, two-tailed test.

To control for the year-specific changes in property values, a set of year dummies are included in the DID regression models for each NR site. The results for these are presented in the table below, with year 1990 representing the base period.

Table A3: Estimates on year dummy coefficients from DID weighted regression-adjusted specification

Year dummies	Maidstone	Ashburton	Broad-meadows	Doveton	Werribee	Hastings	Heidelberg
1991	-0.207	0.054	-0.123	0.041	0.169	-3.320	-0.031
	(0.065)***	(0.062)	(0.108)	(0.052)	(0.063)***	(1.084)***	(0.092)
1992	-0.316	0.079	-0.158	-0.039	0.169	-3.620	-0.012
	(0.085)***	(0.081)	(0.139)	(0.067)	(0.085)**	(1.399)***	(0.127)
1993	-0.388	0.082	-0.209	0.080	0.064	-4.931	0.037
	(0.113)***	(0.095)	(0.162)	(0.077)	(0.097)	(1.532)***	(0.154)
1994	-0.504	0.139	-0.192	0.094	0.159	-5.442	0.003
	(0.140)***	(0.103)	(0.178)	(0.085)	(0.110)	(1.690)***	(0.172)
1995	-0.665	-0.025	-0.231	0.045	0.240	-5.609	-0.052
	(0.179)***	(0.079)	(0.191)	(0.093)	(0.119)**	(1.819)***	(0.195)
1996	-0.702	0.245	-0.232	0.053	0.195	-6.724	0.005
	(0.203)***	(0.125)**	(0.202)	(0.097)	(0.124)	(1.993) ***	(0.204)
1997	-0.837	0.333	-0.252	0.111	0.209	-5.133	-0.033
	(0.231)***	(0.131)**	(0.212)	(0.102)	(0.130)	(2.094)**	(0.217)
1998	-0.959	0.498	-0.109	0.237	0.312	-7.187	-0.071
	(0.264)***	(0.135)***	(0.220)	(0.106)**	(0.136)**	(2.140) ***	(0.2277)
1999	-0.503	0.685	0.090	0.287	0.346	-6.993	0.477
	(0.303)*	(0.142)***	(0.228)	(0.110)***	(0.141)	(2.193) ***	(0.236)**
2000	-0.479	0.778	0.236	0.492	0.486	-7.268	0.592
	(0.326)	(0.156)***	(0.234)	(0.113)***	(0.145)***	(2.263) ***	(0.243)**
2001	-0.309	0.936	0.361	0.564	0.514	-7.239	0.850
	(0.360)	(0.154)***	(0.241)	(0.116)***	(0.149)***	(2.332) ***	(0.250)***
2002	-0.224	1.178	0.583	0.780	0.660	-7.093	1.026
	(0.395)	(0.153)***	(0.246)**	(0.119)***	(0.152)***	(2.396) ***	(0.258)***
2003	-0.143	1.284	0.665	1.002	0.933	-6.868	1.192
	(0.424)	(0.170)***	(0.254)***	(0.121)***	(0.156)***	(2.435) ***	(0.262) ***
2004	-0.213	1.292	0.733	1.104	1.192	-6.995	1.216

Year dummies	Maidstone	Ashburton	Broad-meadows	Doveton	Werribee	Hastings	Heidelberg
	(0.459)	(0.172)***	(0.259)***	(0.124)***	(0.160)***	(2.502) ***	(0.270) ***
2005	-0.374	1.332	0.757	1.129	1.227	-6.749	1.135
	(0.524)	(0.176)***	(0.264)***	(0.126)***	(0.163)***	(2.543) ***	(0.285) ***
2006	-0.357	1.451	0.739	1.126	1.271	-7.115	1.248
	(0.530)	(0.188)***	(0.268)***	(0.129)***	(0.166)***	(2.588) ***	(0.281) ***
2007	-0.345	1.684	0.825	1.280	1.293	-6.869	1.343
	(0.557)	(0.181)***	(0.273)***	(0.131)***	(0.168)***	(2.620) ***	(0.285) ***
2008	-0.287	1.754	1.025	1.399	1.376	-6.548	1.485
	(0.591)	(0.185)***	(0.275)***	(0.132)***	(0.171)***	(2.662)**	(0.291) ***
2009	-0.233	1.788	1.188	1.514	1.491	-6.716	1.632
	(0.624)	(0.187)***	(0.280)***	(0.134)***	(0.173)***	(2.691)**	(0.294) ***
2010	-0.202	2.036	1.352	1.667	1.657	-6.626	1.742
	(0.654)	(0.213)***	(0.284)***	(0.136)***	(0.175)***	(2.735)**	(0.300) ***
2011	-0.187	1.807	1.262	1.672	1.692	-6.879	1.815
	(0.676)	(0.202)***	(0.302)***	(0.139)***	(0.178)***	(2.760)**	(0.302) ***

Note: Standard errors in parentheses * denotes coefficient statistically significant at 10%, two-tailed test;** denotes coefficient statistically significant at 5%, two-tailed test; *** denotes coefficient statistically significant at 1% level, two-tailed test.

In tables A4 and A5, we present regression results generated using the nearest neighbour algorithm, which was also applied to test the sensitivity of our findings to alternative sample design methods. Using Ashburton as an example, results suggest that both the nearest neighbour method and regression-adjusted method generate very similar findings in terms of the size and level of significance of the treatment coefficient. This suggests that our findings are robust to alternative sample design techniques.

Table A4: Nearest neighbour DID estimates for Ashburton NR site

Variables	Cohort	DTreatment	DTreatment*Post	No. of observations	R-squared
Ashburton	2003	-0.231***	0.0925***	2,527	0.872
		(0.0241)	(0.0229)		

Note: Standard errors in parentheses * denotes coefficient statistically significant at 10%, two-tailed test;** denotes coefficient statistically significant at 5%, two-tailed test; *** denotes coefficient statistically significant at 1% level, two-tailed test.

Table A5: Results on covariates from nearest neighbour DID estimates for Ashburton NR site

Variables	Ashburton
Property characteristics	
Land area (log)	0.0736***
	(0.0195)
Floor area (log)	0.176***
	(0.0221)
Number of bedrooms (log)	0.0732***

Variables	Ashburton
	(0.0260)
Age of building (log)	0.0199**
	(0.00969)
Commercial property	-0.0232
	(0.170)
Flat/Unit	0.00775
	(0.0164)
Undeveloped land	-0.231
	(0.169)
Planning	
Time (log)	0.00951
	(0.0465)
Heritage overlay dummy	0.108*
	(0.0615)
Environmental overlay dummy	n/a
Inundation overlay dummy	0.213
	(0.239)
Distance	
Distance to train station (log)	-0.0394***
	(0.0123)
Distance to CBD (log)	-0.723***
	(0.0548)
Distance to activity centre (log)	0.000220
	(0.0444)
Distance to primary school (log)	-0.0776***
	(0.0135)
Distance to secondary school (log)	-0.0348***
	(0.00893)
Socioeconomic Indicator	
Reading rank	-0.0771**
	(0.0352)
ICSEA Value (log)	-0.399
	(0.587)

Note: Standard errors in parentheses * denotes coefficient statistically significant at 10%, two-tailed test;** denotes coefficient statistically significant at 5%, two-tailed test; *** denotes coefficient statistically significant at 1% level, two-tailed test.

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